DRAFT

Grade 4

Science

Item Specifications

Updated December 2019

Missouri
DEPARTMENT OF ELEMENTARY & SECONDARY
EDUCATION

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Introduction

In 2014 Missouri legislators passed House Bill 1490, mandating the development of the Missouri Learning Expectations. In April of 2016, these Missouri Learning Expectations were adopted by the State Board of Education. Groups of Missouri educators from across the state collaborated to create the documents necessary to support the implementation of these expectations.

One of the documents developed is the item specification document, which includes all Missouri grade level/course expectations arranged by domains/strands. It defines what could be measured on a variety of assessments. The document serves as the foundation of the assessment development process.

Although teachers may use this document to provide clarity to the expectations, these specifications are intended for summative, benchmark, and large-scale assessment purposes.

Components of the item specifications include:

Expectation Unwrapped breaks down a list of clearly delineated content and skills the students are expected to know and be able to do upon mastery of the Expectation.

Depth of Knowledge (DOK) Ceiling indicates the highest level of cognitive complexity that would typically be assessed on a large scale assessment. The DOK ceiling is not intended to limit the complexity one might reach in classroom instruction.

Item Format indicates the types of test questions used in large scale assessment. For each expectation, the item format specifies the type best suited for that particular expectation.

Content Limits/Assessment Boundaries are parameters that item writers should consider when developing a large scale assessment. For example, some expectations should not be assessed on a large scale assessment but are better suited for local assessment.

Sample stems are examples that address the specific elements of each expectation and address varying DOK levels. The sample stems provided in this document are in no way intended to limit the depth and breadth of possible item stems. The expectation should be assessed in a variety of ways.

Possible Evidence indicates observable methods in which a student can show understanding of the expectations.

Stimulus Materials defines types of stimulus materials that can be used in the item stems.

<table>
<tr><th colspan="2">Physical Sciences</th><th>4.PS2.A.1</th></tr>
<tr><td>Core Idea
Component
MLS</td><td colspan="2">Motion and Stability: Forces and Interactions
Forces and Motion
Make observations and/or measurements of an object’s motion to provide evidence that a pattern can be used to predict future motion.</td></tr>
<tr><td colspan="2"><u>Expectation Unwrapped</u>

[Clarification Statement: Examples of motion with a predictable pattern could include a child swinging in a swing, a ball rolling back and forth in a bowl, and two children on a see-saw.]

<u>SCIENCE AND ENGINEERING PRACTICES</u>
Planning and Carrying out Investigations
● Make observations and/or measurements to provide evidence for the explanation of a pattern within a phenomenon.

<u>DISCIPLINARY CORE IDEAS</u>
Forces and Motion
● The patterns of an object’s motion in various situations can be observed and measured: when that past motion exhibits a regular pattern, future motion can be predicted from it.

<u>CROSSCUTTING CONCEPTS</u>
Patterns
● Patterns of change can be used to make predictions.</td><td><u>DOK Ceiling</u>
3

<u>Item Format</u>
Selected Response
Constructed Response
Technology Enhanced</td></tr>
<tr><td colspan="2"><u>Content Limits/Assessment Boundaries</u>

● Technical terms, such as period and frequency, should be avoided

<u>Possible Evidence</u>

● Students recognize and then describe the phenomenon under investigation and describe the purpose of the investigation, including the idea that patterns of motion can be used to predict future motion of an object.
● Students recognize and then describe the data to be collected through observations and/or measurements and describe how the data will serve as evidence of a pattern in the motion of an object.</td><td><u>Sample Stems</u>

A student notices that toy cars move faster going downhill. She wonders if steeper hills make things move even faster. Her class builds a wooden ramp to investigate. They test how the height of the wooden ramp might change the speed of a toy car that has a mass of 31 grams. The investigation set up is shown in Figure 1. By measuring the length</td></tr>
</table>

- Students recognize how the data will be collected, including how the motion of the object will be observed and how evidence of the pattern will be recorded, in order to predict a pattern that can be used to predict future motion.
- Students make observations and/or measure an object's speed or distance. From these observed patterns/measurements, students can predict future motion.

Stimulus Materials

Graphic organizers, diagrams, graphs, data tables, drawings

of the ramp with a ruler, and the time it takes the car to reach the end of the ramp with a stopwatch, the students calculate the speed of the car. The results of the investigation are shown in Table 1.

Figure 1. Car on Ramp

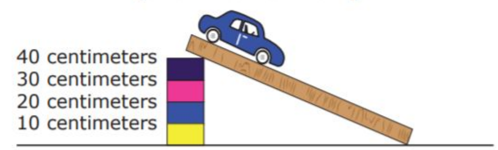
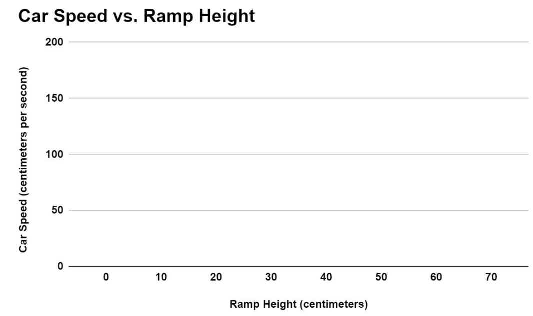


Table 1: Results of Investigation

Ramp Height (cm)	Speed (cm/s)
0	0
10	25
20	50
40	100
50	125

1. Use the data provided in Table 1 to graph the speed of the car at different ramp heights. Then, predict the speed of the car at a ramp height of 60 and 70 centimeters to complete the graph.

Grades 3-5 SCIENCE



Grades 3-5 SCIENCE

<table>
<tr><th colspan="2">Physical Sciences</th><th>4.PS2.A.2</th></tr>
<tr><td>Core Idea</td><td colspan="2">Motion and Stability: Forces and Interactions</td></tr>
<tr><td>Component</td><td colspan="2">Forces and Motion</td></tr>
<tr><td>MLS</td><td colspan="2">Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.</td></tr>
<tr><td colspan="2" rowspan="2"><u>Expectation Unwrapped</u>

[Clarification Statement: Examples could include an unbalanced force on one side of a ball can make it start moving; and, balanced forces pushing on a box from both sides will not produce any motion at all.]

<u>SCIENCE AND ENGINEERING PRACTICES</u>
Planning and carrying out investigations
● Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered.

<u>DISCIPLINARY CORE IDEAS</u>
Motion and Stability: Forces & Interactions—Forces and Motion
● Each force acts on one particular object and has both strength and direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object’s speed or direction of motion.

<u>CROSSCUTTING CONCEPTS</u>
Cause and Effect
● Cause and effect relationships are routinely identified.
● Mechanism and explanation</td><td><u>DOK Ceiling</u>
3</td></tr>
<tr><td><u>Item Format</u>
Selected Response
Constructed Response
Technology Enhanced</td></tr>
<tr><td colspan="2"><u>Content Limits/Assessment Boundaries</u>

● Tasks should not require students to determine quantitative force size. Students should only be determining the qualitative or relative force size.
● Items should not assess a specific sequence in a procedure.</td><td><u>Sample Stems</u>

A student notices that toy cars roll faster going downhill. She wonders if steeper hills make things go even faster. Her class builds a wooden ramp to investigate. They test how the height of the wooden ramp might change the speed of a toy car that has a mass of 31 grams. The investigation set up is shown in Figure 1. By measuring the length of the</td></tr>
</table>

Possible Evidence

- Students will describe the phenomenon (observable event) under investigation, which includes the effects of different forces on an object's motion (e.g., starting, stopping, or changing direction).
- Students will describe the purpose of the investigation, which includes producing the data to serve as the basis for evidence for how balanced and unbalanced forces determine an object's motion.
- Students will collaboratively develop a plan including the change in motion of an object at rest after different strengths and directions of balanced and unbalanced forces are applied and what causes the forces on the object. In the plan, students will describe how the motion of the object will be observed and recorded, including the following information:
  - The object whose motion is being investigated
  - The objects in contact that exert forces on each other
  - Which variable is changing in each trial
  - The number of trials that will be conducted.
- Students collaboratively collect and record data according to the investigation plan, including data from observations and/or measurements of an object at rest and an object in motion and identification of the forces acting on the object.

Stimulus Materials

Graphic organizers, diagrams, graphs, data tables, drawings

ramp with a ruler, and the time it takes the car to reach the end of the ramp with a stopwatch, the students calculate the speed of the car. The results of the investigation are shown in Table 1.

Figure 1. Car on Ramp

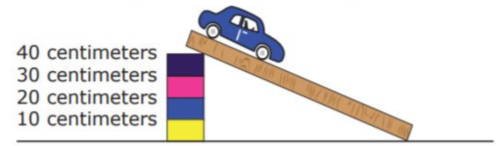


Table 1: Results of Investigation

Ramp Height (cm)	Speed (cm/s)
0	0
10	25
20	50
40	100
50	125

1. When the ramp is placed flat at a height of 0 centimeters, the car remains still. Provide an explanation for why this occurs.
2. Besides changing the angle of the ramp, describe another way the student could make the car travel faster down the ramp.
3. Thinking of your response in question 2, what observations and measurements would you make to prove that your method would make the car travel faster?

<table>
<tr><th colspan="2">Physical Sciences</th><th>4.PS2.B.1</th></tr>
<tr><td>Core Idea</td><td colspan="2">Motion and Stability: Forces and Interactions</td></tr>
<tr><td>Component</td><td colspan="2">Types of Interactions</td></tr>
<tr><td>MLS</td><td colspan="2">Plan and conduct a fair test to compare and contrast the forces (measured by a spring scale in Newtons) required to overcome friction when an object moves over different surfaces (i.e., rough/smooth).</td></tr>
<tr><td colspan="2" rowspan="2"><u>Expectation Unwrapped</u>

<u>SCIENCE AND ENGINEERING PRACTICES</u>
Planning and Carrying out Investigations
● Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered.

<u>DISCIPLINARY CORE IDEAS</u>
Types of Interactions
● The effect of unbalanced forces on an object results in a change of motion. Patterns of motion can be used to predict future motion. Some forces act through contact; some forces act even when the objects are not in contact. The gravitational force of Earth acting on an object near Earth's surface pulls that object toward Earth's center.

<u>CROSSCUTTING CONCEPTS</u>
Cause and Effect
● Cause and effect relationships are routinely identified.
Patterns
● Observed patterns of forms and events guide organizational classification, and they prompt questions about relationships and the factors that influence them.

<u>ENGINEERING DESIGN</u>
● Refer to Engineering, Technology, and Application of Science 4.ETS1B.1.</td><td><u>DOK Ceiling</u>
3</td></tr>
<tr><td><u>Item Format</u>
Selected Response
Constructed Response
Technology Enhanced</td></tr>
<tr><td colspan="2"><u>Content Limits/Assessment Boundaries</u>

● Tasks should not include anything more complex than written or pictorial descriptions.
● Items should not assess a specific sequence in a procedure.</td><td><u>Sample Stems</u>

A coach of a basketball wants to invest in new tennis shoes for his players. The shoes that the players are wearing now have worn</td></tr>
</table>

Grades 3-5 SCIENCE

Possible Evidence

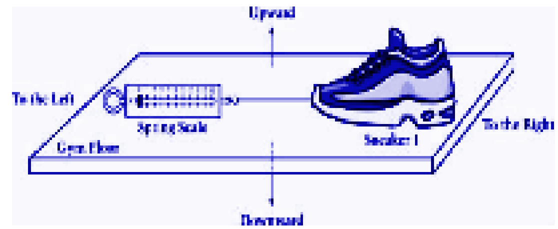
- Students will describe the phenomenon (observable event) being investigated, which includes the amount of force (measured by a spring scale, in Newtons) required to overcome friction when an object moves over different surfaces (i.e., rough/smooth).
- Students will describe the purpose of the investigation, which includes producing the data to serve as the basis for evidence for how friction affects the amount of force.
- Students will collaboratively develop a plan including the amount of force required to overcome friction. In the plan, students will describe how the force will be observed and recorded, including the following information:
    - The object whose motion is being investigated
    - The different surfaces the object encounters
    - Which variable is changing in each trial
    - The number of trials being conducted
- Students collaboratively collect and record data according to the investigation plan, including data from observations and/or measurements of the amount of force required.

Stimulus Materials

Graphic organizers, diagrams, graphs, data tables, drawings

off the treads and are very smooth on the bottoms. This caused the players to slide too much; therefore, the coach decided to test three different brands of tennis shoes. He decided to use a spring scale to pull the tennis shoes across the gym floor as shown in Figure 1.

Figure 1: Tennis Shoe Test



Each shoe that was tested had a different amount of treads (texture) on the bottom of the shoes. See the images below to understand the differences in the bottoms of the 3 shoes he tested.

Shoe A

Shoe B

Shoe C

1. a. Identify the pair of shoes that will have the greatest reading on the spring scale.
   b. Explain your reasoning to Part a.

The coach decided that he wanted shoes that didn't stick too much, making it hard to move. He also didn't want shoes that were too smooth, making his players slide too much.

2. a.Identify which pair of shoes the coach should pick.
   b. Explain your reasoning to part A.

<table>
<tr><th colspan="2">Physical Sciences</th><th>4.PS2.B.2</th></tr>
<tr><td>Core Idea</td><td colspan="2">Motion and Stability: Forces and Interactions</td></tr>
<tr><td>Component</td><td colspan="2">Types of Interactions</td></tr>
<tr><td>MLS</td><td colspan="2">Predict how changes in either the amount of force applied to an object or the mass of the object affects the motion (speed and direction) of the object.</td></tr>
<tr><td colspan="2" rowspan="2"><u>Expectation Unwrapped</u>

<u>SCIENCE AND ENGINEERING PRACTICES</u>
Planning and Carrying Out Investigations
● Make predictions about what would happen if a variable changes.

<u>DISCIPLINARY CORE IDEAS</u>
Types of Interactions
● The effect of unbalanced forces on an object results in a change of motion. Patterns of motion can be used to predict future motion. Some forces act through contact, some forces act even when the objects are not in contact. The gravitational force of Earth acting on an object near Earth's surface pulls that object toward that planet's center.

<u>CROSSCUTTING CONCEPTS</u>
Cause and Effect
● Cause and effect relationships are routinely identified.</td><td><u>DOK Ceiling</u>
3</td></tr>
<tr><td><u>Item Format</u>
Selected Response
Constructed Response
Technology Enhanced</td></tr>
<tr><td colspan="2"><u>Content Limits/Assessment Boundaries</u>

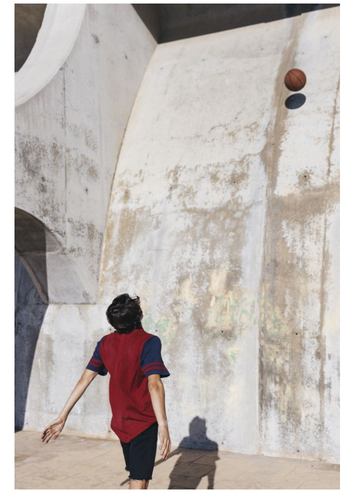
● Tasks should not include anything more complex than written or pictorial descriptions.</td><td rowspan="2"><u>Sample Stems</u>

A student was playing catch by himself and grew tired of throwing the ball into the air. He decided to throw the ball with two different forces against a wall. During trial 1, he threw the ball at the wall with 10N of force. During trial 2, he threw the ball at the wall with 15N of force.</td></tr>
<tr><td colspan="2"><u>Possible Evidence</u>

● Students will change either the amount of applied force or the mass of an object to predict how it will affect the motion (speed and direction) of the object.</td></tr>
</table>

Stimulus Materials

Graphic organizers, diagrams, graphs, data tables, drawings



1. a. Which trial will most likely result in the ball bouncing off the wall and traveling a farther distance?
   b. Explain your reasoning in Part a.

A student has a bowling ball and a basketball shown in Figure 1. The student rolled them both down a smooth floor.

Figure 1: Bowling Ball and Basketball

3.63 kg 0.68 kg

1. a. Which object will require the most amount of force to get the ball to start rolling?
   b. Explain your reasoning to Part A.

Grades 3-5 SCIENCE

Physical Sciences		4.PS3.A.1
Core Idea	**Energy**	
Component	**Definitions of Energy**	
MLS	Use evidence to construct an explanation relating the speed of an object to the energy of that object.	

Expectation Unwrapped

SCIENCE AND ENGINEERING PRACTICES
Constructing Explanations and Designing Solutions
- Use evidence (e.g., measurements, observations, patterns) to construct an explanation.

DISCIPLINARY CORE IDEAS
Definitions of Energy
- Moving objects contain energy. The faster a given object is moving, the more energy it possesses. Energy can be moved from place to place by moving objects.

CROSSCUTTING CONCEPTS
Energy and Matter
- Energy can be transferred in various ways and between objects.

DOK Ceiling

3

Item Format

Selected Response
Constructed Response
Technology Enhanced

Content Limits/Assessment Boundaries

- Tasks should not include quantitative measures of changes in the speed of an object or on any precise or quantitative definition of energy.

Possible Evidence

- Students recognize and then describe evidence explaining the relative speed of an object, the qualitative indicators of the amount of energy of the object, as determined by a transfer of energy from that object (e.g. more or less sound produced in a collision, more or less heat produced when objects rub together, relative speed of a ball that was stationary following a collision with a moving object, more or less distance a stationary object is moved).

Stimulus Materials

Graphic organizers, diagrams, graphs, data tables, drawings

Sample Stems

Table 1 shows the speeds of four cars: A, B, C, and D. The cars are traveling in four different lanes on a highway.

Table 1: Speeds of Cars

Car	Speed (m/s)
A	25.9
B	28.6
C	26.8
D	28.2

	1. List the cars in order from the car with the **most** energy to the car with the **least** energy. 2. Describe the relationship between speed and energy. 3. Give a specific example of how energy can be transferred from one object to another.

Grades 3-5 SCIENCE

Physical Sciences		4.PS3.B.1
Core Idea	**Energy**	
Component	**Conservation of Energy and Energy Transfer**	
MLS	Provide evidence to construct an explanation of an energy transformation (e.g. temperature change, light, sound, motion, and magnetic effects).	

<u>Expectation Unwrapped</u>

<u>SCIENCE AND ENGINEERING PRACTICES</u>

Constructing Explanations and Designing Solutions

- Use evidence (e.g. measurements, observations, patterns) to construct or support an explanation or design a solution to a problem.

<u>DISCIPLINARY CORE IDEAS</u>

Conservation of Energy & Energy Transfer

- Energy can be moved from place to place by moving objects or through sound, light, heat and temperature change, and magnetic effects.

<u>CROSSCUTTING CONCEPTS</u>

Energy and Matter

- Energy can be transferred in various ways and between objects.

<u>DOK Ceiling</u>

3

<u>Item Format</u>

Selected Response
Constructed Response
Technology Enhanced

<u>Content Limits/Assessment Boundaries</u>

- Tasks should not include quantitative measurements of energy.

<u>Possible Evidence</u>

- Students describe the transfer of energy, including collisions between objects, light traveling from one place to another, sound traveling from one place to another, magnetic effects from one object to another, and heat passing from one object to another.
- Students describe the investigation and its purpose and how the data will be observed and collected, including the tools and methods for collection, and record observations to provide evidence that energy is present whenever there are moving objects, sound, light, heat, and magnetic force.

<u>Stimulus Materials</u>

Graphic organizers, diagrams, graphs, data tables, drawings

<u>Sample Stems</u>

At recess, McKinsey noticed that her hands were very cold from being out in the winter weather. Her friend Toynetta's hands were very warm from wearing mittens. Toynetta told McKinsey to hold her hands with her. To McKinsey's surprise, her hands started to warm up.

1. Explain the transfer of energy. Use evidence to support your answer.

<table>
<tr><th colspan="2">Physical Sciences</th><th>4.PS3.B.2</th></tr>
<tr><td>Core Idea</td><td colspan="2">Energy</td></tr>
<tr><td>Component</td><td colspan="2">Conservation of Energy and Energy Transfer</td></tr>
<tr><td>MLS</td><td colspan="2">Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.</td></tr>
<tr><td colspan="2" rowspan="2"><u>Expectation Unwrapped</u>

[Clarification Statement: Examples of devices could include electric circuits that convert electrical energy into motion energy of a vehicle, light, or sound; and, a passive solar heater that converts light into heat. Examples of constraints could include the materials, cost, or time to design the device.]

<u>SCIENCE AND ENGINEERING PRACTICES</u>
Constructing Explanations and Designing Solutions
● Apply scientific ideas to solve design problems.

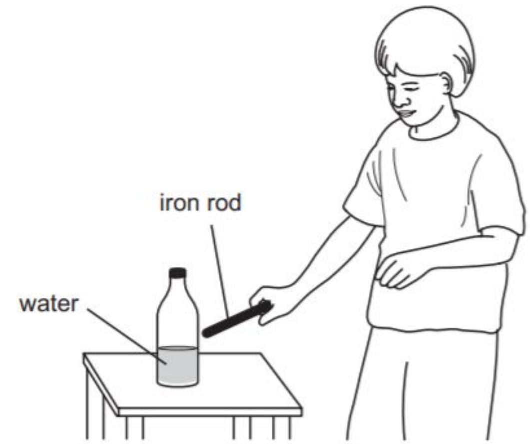
<u>DISCIPLINARY CORE IDEAS</u>
Conservation of Energy and Energy Transfer
● Energy can be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat or light. The currents may have been produced to begin with transforming the energy of motion into electrical energy.

<u>CROSSCUTTING CONCEPTS</u>
Energy & Matter
● Energy can be transferred in various ways and between objects.

<u>ENGINEERING DESIGN</u>
Refer to Engineering, Technology, and Application of Science 4.ETS1A.1
Refer to Engineering, Technology, and Application of Science 4.ETS1B.1
Refer to Engineering, Technology, and Application of Science 4.ETS1C.1</td><td><u>DOK Ceiling</u>
3</td></tr>
<tr><td><u>Item Format</u>
Selected Response
Constructed Response
Technology Enhanced</td></tr>
<tr><td colspan="2"><u>Content Limits/Assessment Boundaries</u>

● Tasks should not include any devices beyond those that convert motion energy to electric energy or use stored energy to cause motion or produce light or sound.</td><td><u>Sample Stems</u>

A student pours water into a glass bottle. Next, the student gently taps the outside of the glass bottle with an iron rod.</td></tr>
</table>

Possible Evidence	
• Given a problem to solve, students collaboratively design a solution that converts energy from one form to another. In the design, the students will identify the device by which the energy will be transformed (e.g., a light bulb to convert electrical energy into light energy, a motor to convert electrical energy into energy of motion.) • Students describe the criteria, which include the initial and final forms of energy and a description of how the solution functions to transfer energy from one form to another, and the constraints, which include the materials available and safety considerations. • Students evaluate the solution, test the device, and use the results to modify the design.	 1. a. Which of the following ideas is most likely being investigated by the student? **a. energy transfer through materials** b. heat conduction through materials c. magnetic properties of materials d. reflective properties of materials b. List and describe observations that would best support the answer to Part A.
Stimulus Materials Graphic organizers, diagrams, graphs, data tables, drawings	

Grades 3-5 SCIENCE

Physical Sciences		4.PS3.C.1
Core Idea	**Energy**	
Component	**Relationship between Energy and Forces**	
MLS	Use models to explain that simple machines change the amount of effort force and/or direction of force.	

Expectation Unwrapped

SCIENCE AND ENGINEERING PRACTICES
Developing and Using Models
- Develop a model using an analogy, example, or abstract representation to describe a scientific principle.

DISCIPLINARY CORE IDEAS
Relationship Between Energy and Forces
- A simple machine can change the amount of force or distance necessary to do work.

CROSSCUTTING CONCEPTS
System and System Models
- A system can be described in terms of its components and their interactions.

DOK Ceiling

3

Item Format

Selected Response
Constructed Response
Technology Enhanced

Content Limits/Assessment Boundaries

- Tasks should not include the memorization of simple machines.

Possible Evidence

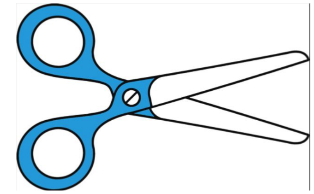
- Students use the model to explain how simple machines (e.g., lever, pulley, inclined plane, wheel and axle, screw, wedge, gear) change the amount of effort force and/or direction of force.

Stimulus Materials

Graphic organizers, diagrams, graphs, data tables, drawings.

Sample Stems

1. a. The simple machine above makes work easier. What type of simple machine is pictured above?
   b. Describe how this machine makes work easier.



1. a. Identify the types of simple machines in a pair of scissors.
   b. Revise the model above to label the simple machines identified in Part A.

Lifting a bale of hay is not an easy task. Farmer John wanted to store the hay in the loft of his barn but he could not budge the bale. He consulted the high school's science teacher for help. She suggested a simple machine. Farmer John's options included an inclined plane, a pulley, and a lever.

1. a. If he had to lift the bale of cotton to a height of 15ft, which would be the **most** practical solution, requiring the least effort force?
   b. Explain your answer to Part A.

Grades 3-5 SCIENCE

Physical Sciences		4.PS4.A.1
Core Idea	**Waves and Their Applications in Technologies for Information Transfer**	
Component	**Wave Properties**	
MLS	Develop a model of waves to describe patterns in terms of amplitude or wavelength and that waves can cause objects to move.	

Expectation Unwrapped	**DOK Ceiling**
[Clarification Statement: Examples of models could include diagrams, analogies, and physical models using wire to illustrate wavelength and amplitude of waves.] **SCIENCE AND ENGINEERING PRACTICES** **Developing & Using Models** ● Develop a model using an analogy, example, or abstract representation to describe a scientific principle. **DISCIPLINARY CORE IDEAS** **Wave Properties** ● Waves, which are regular patterns of motion, can be made in water by disturbing the surface. When waves move across the surface of deep water, the water goes up and down in place; there is no net motion in the direction of the wave except when the water meets a beach. Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks). **CROSSCUTTING CONCEPTS** **Patterns** ● Similarities and differences in patterns can be used to sort, classify, and analyze simple rates of change for natural phenomena.	3 **Item Format** Selected Response Constructed Response Technology Enhanced

Content Limits/Assessment Boundaries	**Sample Stems**
● Tasks should not include interference effects, electromagnetic waves, non-periodic waves, or quantitative models of amplitude and wavelength. ● Tasks should not assess rote memorization of the terms amplitude and wavelength should not be assessed. (Definitions will not be assessed.)	Students on a playground are not able to hear their teacher's whistle. They decide to test three new whistles to identify a whistle they can hear. They use a special app on a cell phone placed 3 meters away from the whistles to examine the sound waves from each whistle. Figure 1 shows the height of each sound wave. Figure 2 shows the spacing

Possible Evidence

- Students develop a model (e.g., diagrams, analogies, examples, abstract representations, physical models) to identify the relevant components including waves, wave amplitude, wavelength, and motion of objects.
- Students will use the model to describe waves in terms of patterns of repeating amplitude and wavelength, their initiation, and how waves cause an object to move and to describe that the motion of objects varies with the amplitude and wavelength of the wave carrying it.
- Students identify similarities and differences in patterns underlying waves and use these patterns to describe simple relationships involving wave amplitude, wavelength and the motion of an object (e.g., when the amplitude increases, the object moves more).

Stimulus Materials

Graphic organizers, diagrams, graphs, data tables, drawings

between each wave peak. Next, they explore whether the sound that comes out of each whistle can move objects. They place several, identical small foam balls on a table. Students blow each whistle 1 meter away from the foam balls. They record their observations in Table 1.

Figure 1. Height of Sound Waves of Whistles

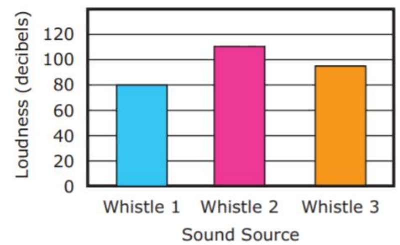


Figure 2. Spacing of Sound Waves of Whistles

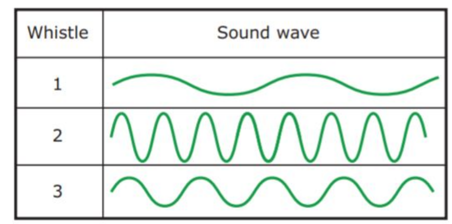


Table 1. Movement of Foam Balls

Whistle	Distance Foam Ball Rolled
1	0 centimeters
2	2 centimeters
3	1 centimeter

1. The students study the wave patterns in Figure 2. One student comments that Whistle 2 has the shortest spacing between wave peaks. What else is true about Whistle 2?

Grades 3-5 SCIENCE

<table>
<tr><th colspan="2">Life Sciences</th><th>4.LS1.A.1</th></tr>
<tr><td>Core Idea
Component
MLS</td><td colspan="2">From Molecules to Organisms: Structure and Processes
Structure and Function
Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and plant reproduction.</td></tr>
<tr><td colspan="2"><u>Expectation Unwrapped</u>

[Clarification Statement: Examples of structures could include thorns, stems, roots, colored petals, heart, stomach, lung, brain, and skin.]

<u>SCIENCE AND ENGINEERING PRACTICES</u>
Engaging in Argument for Evidence
● Construct an argument with evidence, data, and/or a model.

<u>DISCIPLINARY CORE IDEAS</u>
Structure and Function
● Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction

<u>CROSSCUTTING CONCEPTS</u>
Systems and System Models
● A system can be described in terms of its components and their interactions.</td><td><u>DOK Ceiling</u>
3

<u>Item Format</u>
Selected Response
Constructed Response
Technology Enhanced</td></tr>
<tr><td colspan="2"><u>Content Limits/Assessment Boundaries</u>

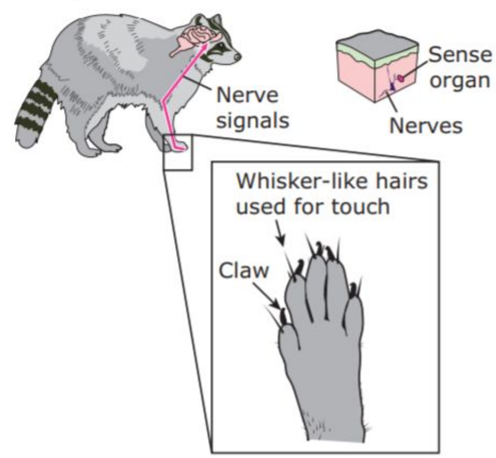
● Tasks should not include any structures beyond macroscopic structures within plant and animal systems.</td><td><u>Sample Stems</u>

A student sees a video of a raccoon searching for food around a pond. The raccoon finds a small piece of fruit and holds it with both of its paws. The raccoon rolls the fruit in its paws under the water and does this several times before eating it. The student wonders how the raccoon holds onto the fruit and why the raccoon rolls the fruit in the water. After doing some research, the student</td></tr>
</table>

<table>
<tr>
<td>
<u>Possible Evidence</u>

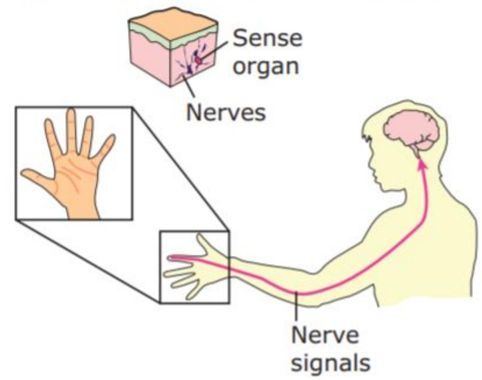
Students make claims that plants and animals have internal and external structures that function together as part of a system to support survival, growth, behavior, and reproduction.
Students describe the internal and external structures and their functions.
Students determine the strength and weakness of the evidence, its relevancy towards the role of internal and external structures in plants and animals in supporting survival, growth, behavior, and reproduction.
Students construct an argument that includes the ideas that plants and animals have structures that, together, support survival, growth, behavior, and/or reproduction.
Students use reasoning that includes the following:

Internal and external structures serve specific functions within plants and animals (e.g., the heart pumps blood to the body, thorns discourage predators)
The functions of internal and external structures can support survival, growth, behavior and/or reproduction in plants and animals (e.g., the heart pumps blood throughout the entire body, which allows the entire body access to oxygen and nutrients; thorns prevent predation, which allows the plant to grow and reproduce)
Different structures work together as part of a system to support survival, growth, behavior, and/or reproduction (e.g., the heart works with the lungs to carry oxygenated blood throughout the system; thorns protect the plant, allowing reproduction via stamens and pollen to occur)

</td>
<td rowspan="2">
learns the following facts:
• Raccoons eat both plants and animals like humans do.
• Raccoons prefer to find food at night and sleep during the day.
• Raccoons roll items around in their paws under water because the water improves their sense of touch.
• Even if there is no water around, raccoons will roll items around in their paws.
• Raccoons can hold objects with their paws, but they cannot grasp objects as well as humans do.
• Humans have opposable thumbs, which means that humans can touch the tip of the thumb to the tip of every other finger. Raccoon thumbs are not opposable.
Later, the student finds more information about the sense of touch in raccoons and humans that is shown in Figures 1 and 2.
Figure 1. Raccoon Sense of Touch


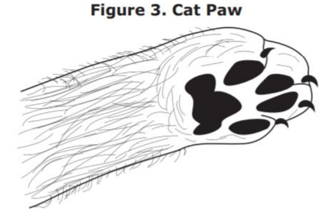
</td>
</tr>
<tr>
<td>
<u>Stimulus Materials</u>
Graphic organizers, diagrams, graphs, data tables, drawings
</td>
</tr>
</table>

Figure 2. Human Sense of Touch



1. Compare the image of the cat paw in Figure 3 to the raccoon paw in Figure 1. What are some advantages of the raccoon paw?

Figure 3. Cat Paw



Write each answer in the correct box. Not all answers will be used. Each answer may be used more than once.

A. easier	B. food	C. harder	D. longer	E. predators	F. shorter

The raccoon paw has ______ toes that make it ______ to hold objects when searching for ______. This trait makes it ______ for the raccoon to survive in its environment.

2. Explain how an external structure, other than its paws, allows a raccoon to survive.

Grades 3-5 SCIENCE

<table>
<tr><th colspan="2">Life Sciences</th><th>4.LS1.D.1</th></tr>
<tr><td>Core Idea</td><td colspan="2">From Molecules to Organisms: Structure and Processes</td></tr>
<tr><td>Component</td><td colspan="2">Information Processing</td></tr>
<tr><td>MLS</td><td colspan="2">Use a model to describe that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways.</td></tr>
<tr><td colspan="2" rowspan="2"><u>Expectation Unwrapped</u>

[Clarification Statement: Emphasis is on systems of information transfer.]

<u>SCIENCE AND ENGINEERING PRACTICES</u>
Developing and Using Models
● Use a model to test interactions concerning the functioning of a natural system.

<u>DISCIPLINARY CORE IDEAS</u>
Information Processing
● Different sense receptors are specialized for particular kinds of information, which may be then processed by the animal’s brain. Animals are able to use their perceptions and memories to guide their interaction.

<u>CROSSCUTTING CONCEPTS</u>
System and System Models
● A system can be described in terms of its components and their interactions.</td><td><u>DOK Ceiling</u>
3</td></tr>
<tr><td><u>Item Format</u>
Selected Response
Constructed Response
Technology Enhanced</td></tr>
<tr><td colspan="2"><u>Content Limits/Assessment Boundaries</u>

● Tasks should not include the mechanisms by which the brain stores and recalls information or the mechanisms of how sensory receptors function.</td><td rowspan="2"><u>Sample Stems</u>

A student sees a video of a raccoon searching for food around a pond. The raccoon finds a small piece of fruit and holds it with both of its paws. The raccoon rolls the fruit in its paws under the water and does this several times before eating it. The student wonders how the raccoon holds onto the fruit and why the raccoon rolls the fruit in the water. After doing some research, the student learns the following facts:</td></tr>
<tr><td colspan="2"><u>Possible Evidence</u>

● Students use a given model to identify and describe the relevant components, which include different types of information about the surroundings (e.g., sound, light, odor, temperature), sense receptors able to detect different types of information from the environment, brain, and animals’ actions.
● Students describe the relationships between components, including types of sense receptors that send information about the surroundings to the brain, processing the information from the sensory receptors,</td></tr>
</table>

and describe that the memories processed by the brain influence an animal's actions or responses to environmental features. Different types of sensory information are relayed to the brain via different sensory receptors, allowing experiences to be perceived, to be stored as memories, and to influence behavior (e.g., an animal sees a brown, rotten fruit and smells a bad odor — this information allows the animal to make decisions about what to eat).

- Students also use the model to test interactions involving sensory perception and its influence on animal behavior, including interactions between animal behavior and information in the environment, different types of sense receptors, perception, and memory of sensory information.

Stimulus Materials

Graphic organizers, diagrams, graphs, data tables, drawings

- Raccoons eat both plants and animals like humans do.
- Raccoons prefer to find food at night and sleep during the day.
- Raccoons roll items around in their paws under water because the water improves their sense of touch.
- Even if there is no water around, raccoons will roll items around in their paws.
- Raccoons can hold objects with their paws, but they cannot grasp objects as well as humans do.
- Humans have opposable thumbs, which means that humans can touch the tip of the thumb to the tip of every other finger. Raccoon thumbs are not opposable.

Later, the student finds more information about the sense of touch in raccoons and humans that is shown in Figures 1 and 2.

Figure 1. Raccoon Sense of Touch

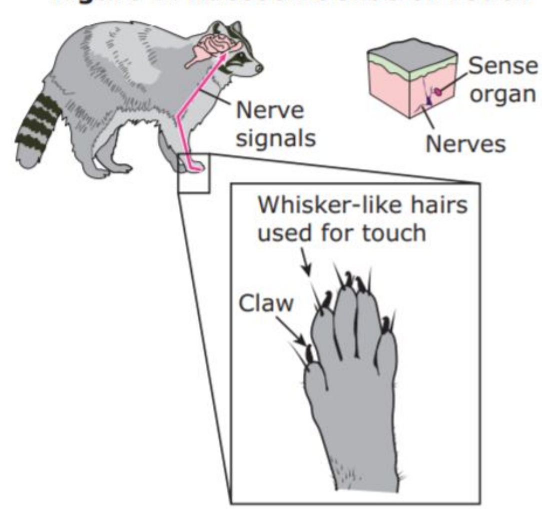
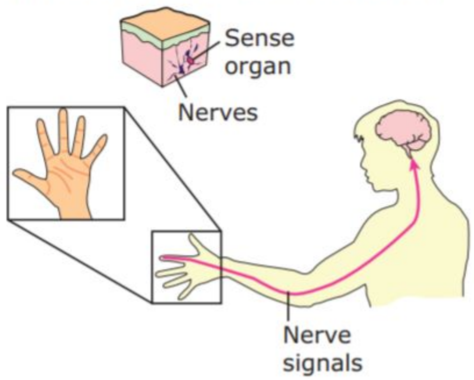


Figure 2. Human Sense of Touch



1. The same raccoon later finds another piece of the same type of fruit and rolls the fruit in its paws under the water. What events will likely follow this one?

Write the answers in the table to correctly order the events.

A. The raccoon's brain processes sensory signals.

B. The raccoon knows the fruit is safe to eat and takes a bite.

C. Whisker-like hairs on the paws send sensory signals to the raccoon's brain.

D. The raccoon remembers what it learned about the fruit it has already eaten.

Step	Event
1	The raccoon rolls the fruit in its paws under the water.
2	
3	
4	
5	

	2. 75% of the sensory part of a raccoon's brain is dedicated to processing touch. Explain how this is important for the survival of a raccoon. 3. Only 8% of the sensory part of a human's brain is dedicated to processing touch. Explain how senses other than touch are important for the survival of a human.

<table>
<tr><th colspan="2">Earth and Space Sciences</th><th>4.ESS1.C.1</th></tr>
<tr><td>Core Idea
Component
MLS</td><td colspan="2">Earth's Place in the Universe
The History of Planet Earth
Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time.</td></tr>
<tr><td colspan="2" rowspan="2"><u>Expectation Unwrapped</u>

[Clarification Statement: Examples of evidence from patterns could include rock layers with marine shell fossils above rock layers with plant fossils and no shells, indicating a change from land to water over time; and, a canyon with different rock layers in the walls and a river in the bottom, indicating that over time a river cut through the rock.]

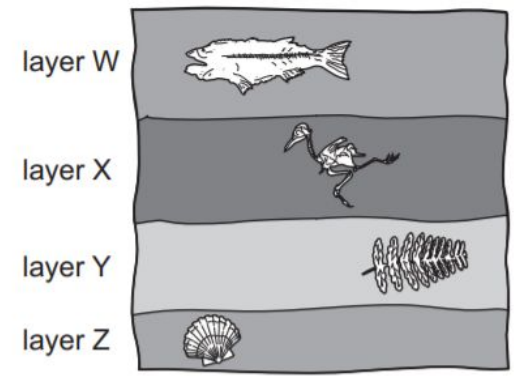
<u>SCIENCE AND ENGINEERING PRACTICES</u>
Constructing Applications and Designing Solutions
● Identify the evidence that supports particular points in an explanation.

<u>DISCIPLINARY CORE IDEAS</u>
The History of Planet Earth
● Local, regional, and global patterns of rock formations reveal changes over time due to Earth forces such as earthquakes. The presence and location of certain fossil types indicate the order in which rock layers were formed.

<u>CROSSCUTTING CONCEPTS</u>
Patterns
● Patterns can be used as evidence to support an explanation.
Stability and Change
● For natural and built systems alike, conditions of stability and determinants of rates of change or evolution of a system are critical elements of study.</td><td><u>DOK Ceiling</u>
3</td></tr>
<tr><td><u>Item Format</u>
Selected Response
Constructed Response
Technology Enhanced</td></tr>
<tr><td colspan="2"><u>Content Limits/Assessment Boundaries</u>

● Tasks should not include specific knowledge of the mechanism of rock formation or memorization of specific rock formations and layers.</td><td><u>Sample Stems</u>

A scientist observes layers of sedimentary rock on a cliff. The layers of sedimentary rock contain fossils. The scientist makes a drawing</td></tr>
</table>

Possible Evidence	of the observations.
● Students identify the explanation and the evidence relevant to supporting the explanation, including local and regional patterns in the following: ○ The different rock layers found in an area (e.g., rock layers taken from the same location show marine fossils in some layers and land fossils in other layers) ○ The ordering of rock layers (e.g., layer with marine fossils is found below layer with land fossils) ○ The presence of particular fossils (e.g., shells, land plants) in specific rock layers ○ The occurrence of events (e.g., earthquakes) due to Earth forces ● Students connect the evidence to support particular points of the explanation, including how specific rock layers in the same location show specific fossil patterns (e.g., some lower rock layers have marine fossils, while some higher rock layers have fossils of land plants). This pattern indicates that the landscape of the area was transformed into the landscape indicated by the upper layer (e.g., lower marine fossils indicate that, at one point, the landscape was covered by water, and upper land fossils indicate that the landscape was later dry land), and irregularities in the patterns of rock layers indicate disruptions due to Earth forces (e.g., a canyon with different rock layers in the walls and a river in the bottom, indicating that over time a river cut through the rock).	The scientist's drawing is shown:  1. a. Identify the older layer of rock on the cliff. b. Use evidence from the drawing to explain your answer to part A.
Stimulus Materials Graphic organizers, diagrams, graphs, data tables, drawings	

Grades 3-5 SCIENCE

<table>
<tr><th colspan="2">Earth and Space Sciences</th><th>4.ESS2.A.1</th></tr>
<tr><td>Core Idea</td><td colspan="2">Earth's Systems</td></tr>
<tr><td>Component</td><td colspan="2">Earth Materials and Systems</td></tr>
<tr><td>MLS</td><td colspan="2">Plan and conduct scientific investigations or simulations to provide evidence how natural processes (e.g. weathering and erosion) shape Earth's surfaces.</td></tr>
<tr><td colspan="2" rowspan="2"><u>Expectation Unwrapped</u>

[Clarification Statement: Examples of variables to test could include angle of slope in the downhill movement of water, amount of vegetation, speed of wind, relative rate of deposition, cycles of freezing and thawing of water, cycles of heating and cooling, and volume of water flow.]

<u>SCIENCE AND ENGINEERING PRACTICES</u>
Planning and Carrying Out Investigations
● Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered.

<u>DISCIPLINARY CORE IDEAS</u>
Earth Materials and Systems
● Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around.

<u>CROSSCUTTING CONCEPTS</u>
Cause and Effect
● Cause and effect relationships are routinely identified, tested, and used to explain change.

<u>ENGINEERING DESIGN</u>
Refer to Engineering, Technology, and Application of Science 4.ETS1B.1</td><td><u>DOK Ceiling</u>
3</td></tr>
<tr><td><u>Item Format</u>
Selected Response
Constructed Response
Technology Enhanced</td></tr>
<tr><td colspan="2"><u>Content Limits/Assessment Boundaries</u>

● Tasks should not include more than one variable to test for weathering and erosion.
● Items should not assess a specific sequence in a procedure.</td><td><u>Sample Stems</u>

Students in the 4th grade want to investigate erosion along the local creek in their town.</td></tr>
</table>

Possible Evidence

- Students recognize and then provide evidence for the effects of weathering or the rate of erosion of Earth's materials.
- Students describe the data to be collected and the evidence needed based on observations and/or measurements made during the investigation, which includes the change in the relative steepness of slope of the area; the kind of weathering or erosion to which the Earth material is exposed; and the change in shape of Earth materials as the result of weathering or the rate of erosion by motion of water, ice (including melting and freezing), wind (speed and direction), and vegetation.
- Students describe how the data will be collected, including the relative speed of the flow of air or water, the number of cycles of freezing and thawing, the number and types of plants growing in the Earth material, the amount of soil, and number or size of rocks transported by erosion and how the collected data will serve as evidence to address the purpose, including to help identify the cause and effect relationships between weathering or erosion and Earth materials.
- Students describe the controlled variables, including: variables that affect movement of water and air, the water temperature and forms of matter, and the presence or absence of plants growing in or on the Earth material.

Stimulus Materials

Graphic organizers, diagrams, graphs, data tables, drawings

They wanted to know if grass, rocks, or soil eroded more with water. Figure 1 shows the set up of the investigation and Table 1 shows the results of the investigation.

Figure 1: Erosion Set Up

Table 1: Erosion Results

Material	Amount of Water Poured (mL)	Amount of Water Collected(mL)
Grass	709.8	295.7
Rock	473.2	236.6
Soil	236.6	88.7

After performing their investigation, the students decided grass eroded more with water and soil.

1. Did the 4th grade students construct a fair test to determine which eroded more? Explain your answer.

Grades 3-5 SCIENCE

Earth and Space Sciences		4.ESS2.B.1
Core Idea	**Earth's Systems**	
Component	**Plate Tectonics and Large-Scale Systems**	
MLS	Analyze and interpret data from maps to describe patterns of Earth's features.	

Expectation Unwrapped	**DOK Ceiling** 3
[Clarification Statement: Maps can include topographic maps of Earth's land and ocean floor, as well as maps of the locations of mountains, continental boundaries, volcanoes, and earthquakes.] **SCIENCE AND ENGINEERING PRACTICES** **Analyzing and Interpreting Data** ● Analyze and interpret data to make sense of phenomena using logical reasoning. **DISCIPLINARY CORE IDEAS** **Plate Tectonics and Large-Scale Systems** ● The locations of mountain ranges, deep ocean trenches, ocean floor structures, earthquakes, and volcanoes occur in patterns. Most earthquakes and volcanoes occur in bands that are often along the boundaries between continents and oceans. Major mountain chains form inside continents or near their edges. Maps can help locate the different land and water features of Earth. **CROSSCUTTING CONCEPTS** **Patterns** ● Patterns can be used as evidence to support an explanation.	**Item Format** Selected Response Constructed Response Technology Enhanced
Content Limits/Assessment Boundaries	**Sample Stems**
● Topographic maps at this grade level should only include simple mountains, valleys and hills.	Analyze the data found in the table below showing earthquakes in Indonesia.

Possible Evidence

- Students organize data using graphical displays (e.g., table, chart, graph) from maps of Earth's features (e.g., locations of mountains, continental boundaries, volcanoes, earthquakes, deep ocean trenches, ocean floor structures).
- Students identify patterns in the location of Earth's features, including volcanoes and earthquakes occurring in bands that are often along the boundaries between continents and oceans and the major mountain chains that form inside continents or near their edges.
- Students use logical reasoning based on the organized data to make sense of the patterns within the formation of Earth's features.

Stimulus Materials

Graphic organizers, diagrams, graphs, data tables, drawings

Landform	Area	Date	Magnitude
Mountains	 Indonesia	March 3, 2019	4.9
Mountains	 Indonesia	March 4, 2019	4.8
Edge of an island	 Indonesia	March 6, 2019	4.6
Ocean	 Indonesia	March 7, 2019	5.1
Ocean	 Indonesia	March 8, 2019	5.1
Ocean	 Indonesia	March 9, 2019	5.2

1. What information can be concluded after analyzing the table?

Grades 3-5 SCIENCE

<table>
<tr><th colspan="2">Earth and Space Sciences</th><th>4.ESS3.A.1</th></tr>
<tr><td>Core Idea</td><td colspan="2">Earth and Human Activity</td></tr>
<tr><td>Component</td><td colspan="2">Natural Resources</td></tr>
<tr><td>MLS</td><td colspan="2">Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.</td></tr>
<tr><td colspan="2"><u>Expectation Unwrapped</u>

[Clarification Statement: Examples of solutions could include designing an earthquake resistant building and improving monitoring of volcanic activity.]

<u>SCIENCE AND ENGINEERING PRACTICES</u>
Constructing Explanations and Designing Solutions
● Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution.

<u>DISCIPLINARY CORE IDEAS</u>
Natural Resources
● A variety of hazards result from natural processes (e.g., earthquakes, floods, tsunamis, volcanic eruptions, landslides, hurricanes). Humans cannot eliminate the hazards but can take steps to reduce their impacts.

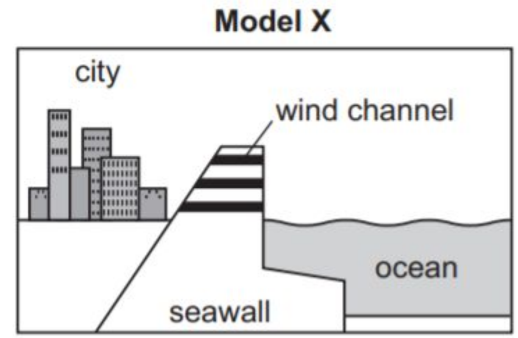
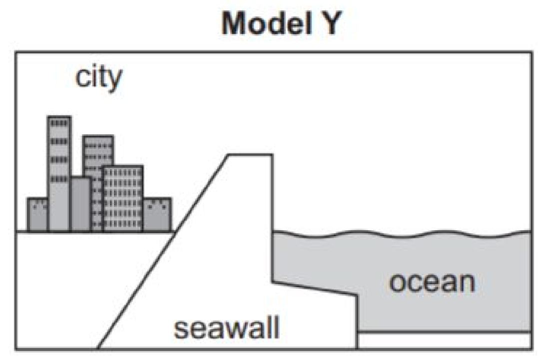
<u>CROSSCUTTING CONCEPTS</u>
Cause and Effect
● Cause and effect relationships are routinely identified, tested, and used to explain changes.

<u>ENGINEERING DESIGN</u>
Refer to Engineering, Technology, and Application of Science 4.ETS1B.1
Refer to Engineering, Technology, and Application of Science 4.ETS1C.1</td><td><u>DOK Ceiling</u>
3

<u>Item Format</u>
Selected Response
Constructed Response
Technology Enhanced</td></tr>
<tr><td colspan="2"><u>Content Limits/Assessment Boundaries</u>

● Tasks should not include any natural process beyond earthquakes, floods, tsunamis, volcanic eruptions, landslides, or hurricanes.</td><td><u>Sample Stems</u>

A seawall is designed to protect cities from the effects of a hurricane. A student developed two seawall models to possibly reduce the impacts of a hurricane on a nearby city.</td></tr>
</table>

Possible Evidence	
• When given a natural Earth process that can have a negative effect on humans (e.g., earthquakes, floods, tsunamis, volcanic eruptions, landslides, hurricanes), students describe and use cause and effect relationships between the Earth process and its observed effect to design at least two solutions that reduce its effect on humans. • Students describe the criteria and constraints of the solution (e.g., cost, materials, time, relevant scientific information). • Students evaluate, compare, and make improvements on each design solution based on how well it meets each of the given criteria and constraints.	1. Which pair of statements identifies the model that would be most effective at decreasing the impacts of a hurricane and explains why? a. Model Y would be most effective. The seawall would stop wind from directly hitting the buildings in the city. **b. Model Y would be most effective. The seawall would reduce the amount of ocean water that could rise up and flood the city.**
Stimulus Materials Graphic organizers, diagrams, graphs, data tables, drawings	

	c. Model X would be most effective. The wind channels would allow water to flow through the seawall and decrease wave action. d. Model X would be most effective. The wind channels would allow wind to flow through the seawall and reduce the amount of water that could flood the city.

<table>
<tr><th colspan="2">Engineering, Technology, and Application of Science</th><th>4.ETS1.A.1</th></tr>
<tr><td>Core Idea</td><td colspan="2">Engineering Design</td></tr>
<tr><td>Component</td><td colspan="2">Defining and Delimiting Engineering Problems</td></tr>
<tr><td>MLS</td><td colspan="2">Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.</td></tr>
<tr><td colspan="2" rowspan="2"><u>Expectation Unwrapped</u>

[Clarification: Engineering Standards should be ongoing and continually integrated into science lessons/units. The ETS standards are written as a 3–5 grade span endpoint. Therefore, by the end of grade 5, students should be proficient in these skills. In grade 4, this engineering standard will be most successful when paired with, but not limited to, the following standards:
4.ESS3.A.1: Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.
4.PS3.B.2: Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.]

<u>SCIENCE AND ENGINEERING PRACTICES</u>
Asking Questions and Defining Problems
● Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost.

<u>DISCIPLINARY CORE IDEAS</u>
Defining and Delimiting Engineering Problems
● Possible solutions to a problem are limited by the available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.

<u>CROSSCUTTING CONCEPTS</u>
● N/A

<u>INFLUENCE OF SCIENCE, ENGINEERING, AND TECHNOLOGY ON SOCIETY AND THE NATURAL WORLD</u>
● People’s needs and wants change over time, as do their demands for new and improved technologies.</td><td><u>DOK Ceiling</u>
3</td></tr>
<tr><td><u>Item Format</u>
Selected Response
Constructed Response
Technology Enhanced</td></tr>
</table>

Grades 3-5 SCIENCE

Content Limits/Assessment Boundaries	Sample Stems
● N/A **Possible Evidence** ● Students identify the problem to be solved and define the boundaries of the system, the criteria, and the constraints or limitations on their design, which may include cost, materials, and time. **Stimulus Materials** Graphic organizers, diagrams, graphs, data tables, drawings	The people in Delaware love their town. However, recently, the road in town has been flooding when a lot of rain falls. Just this past month, the rain has caused flooding and the main road has been washed away.  1. Identify and describe the problem the town is experiencing. Problem: Description of problem:

<table>
<tr><th colspan="2">Engineering, Technology, and Application of Science</th><th>4.ETS1.B.1</th></tr>
<tr><td>Core Idea</td><td colspan="2">Engineering Design</td></tr>
<tr><td>Component</td><td colspan="2">Developing Possible Solutions</td></tr>
<tr><td>MLS</td><td colspan="2">Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.</td></tr>
<tr><td colspan="2">
<u>Expectation Unwrapped</u>
[Clarification: Engineering Standards should be ongoing and continually integrated into science lessons/units. The ETS standards are written as a 3–5 grade span endpoint. Therefore, by the end of grade 5, students should be proficient in these skills. In grade 4, this engineering standard will be most successful when paired with, but not limited to, the following standards:
4.PS2.B.1: Plan and conduct a fair test to compare and contrast the forces required to overcome friction when an object moves over different surfaces.
4.PS3.B.2: Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.
4.ESS2.A.1: Plan and conduct scientific investigations or simulations to provide evidence of how natural processes shape Earth’s surfaces.
4.ESS3.A.1: Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.]
<u>SCIENCE AND ENGINEERING PRACTICES</u>
Constructing Explanations and Designing Solutions
Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design problem.
<u>DISCIPLINARY CORE IDEAS</u>
Developing Possible Solutions
Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions.
<u>CROSSCUTTING CONCEPTS</u>
N/A
<u>INFLUENCE OF SCIENCE, ENGINEERING, AND TECHNOLOGY ON SOCIETY AND THE NATURAL WORLD</u>
Engineers improve existing technologies or develop new ones to increase their benefits, decrease known risks, and meet societal demands.
</td><td>
<u>DOK Ceiling</u>
3
<u>Item Format</u>
Selected Response
Constructed Response
Technology Enhanced
</td></tr>
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Grades 3-5 SCIENCE

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Content Limits/Assessment Boundaries

- N/A

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Sample Stems

The people in Delaware love their town. However, recently, the road in town has been flooding when a lot of rain falls. Just this past month, the rain has caused flooding and the main road has been washed away.

1. What are two possible solutions the town could implement to solve their problem?

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Possible Evidence

- Students use information from research and generate two possible solutions to the problem.
- Students share ideas to generate a variety of possible solutions and describe the necessary steps for designing a solution to the problem. Students describe the given criteria and constraints and how they will be used to generate and test the design solutions.
- Students test each solution, gather data to determine how well the solution meets the criteria, and compare solutions.

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Stimulus Materials

Graphic organizers, diagrams, graphs, data tables, drawings

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Grades 3-5 SCIENCE

Engineering, Technology, and Application of Science		4.ETS1.C.1
Core Idea	**Engineering Design**	
Component	**Optimizing the Solution Process**	
MLS	Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.	

Expectation Unwrapped	**DOK Ceiling**
	3
[Clarification: Engineering Standards should be ongoing and continually integrated into science lessons/units. The ETS standards are written as a 3-5 grade span endpoint. Therefore, by the end of grade 5, students should be proficient in these skills. In grade 4, this engineering standard will be most successful when paired with, but not limited to, the following standards: 4.ESS3.A.1: Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans. 4.PS3.B.2: Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.] **SCIENCE AND ENGINEERING PRACTICES** **Planning and Carrying Out Investigations** ● Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. **DISCIPLINARY CORE IDEAS** **Optimizing the Solution Process** ● Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved. Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints. **CROSSCUTTING CONCEPTS:** ● N/A	**Item Format** Selected Response Constructed Response Technology Enhanced
Content Limits/Assessment Boundaries ● Items should not assess a specific sequence in a procedure.	**Sample Stems** Two homeowners were trying to determine the best material they should use when building a new home. They wanted to make certain their new home could not be

Possible Evidence

- Students describe the purpose of the investigation and the evidence to be collected. Aspects that can be improved to better meet the criteria and constraints are identified.
- Students create a plan for the investigation that includes what is to be changed in each trial (independent variable), the outcome that will be measured (dependent variable), what tools and methods will be used to collect data, and what is to be kept the same to ensure a fair test.
- Students will carry out the investigation according to the developed plan.

Stimulus Materials

Graphic organizers, diagrams, graphs, data tables, drawings

destroyed by a tornado. While researching, they came across the data table below:

Material	Wind Speed (m/s)	Time Exposed to Wind Speed (sec)
Concrete	53.6	1200
Wood	15.6	1320
Brick	32.2	1440

After reviewing the data, the homeowners determined a home made of wood was least likely to be destroyed by a tornado.

1. Were the homeowners provided with enough information to make this claim? Explain.